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BIOLOGICAL EVALUATION

SPRUCE BUDWORM INFESTATIONS IN COLORADO IN 1960

B. H. Wilford and M. E. McKnight

The spruce budworm outbreak in the Douglas-fir and true fir stands in Colorado is at an all time high and is more threatening than ever before on record. The areas of defoliation, as delineated during the 1960 aerial survey when foliage injury was most pronounced, embraced over one-half million acres, one third again that of 1959.

Tree mortality in the areas of infestation is becoming increasingly evident from the air, particularly where defoliation has been moderate to heavy for two or more years. Examination of some areas on the ground reveal an even more alarming view of tree damage; extensive mortality and malformation of much of the understory, both young reproduction and pole-size second-growth.

The budworm has not been noticeably selective as regards tree site quality; it has been indiscriminate, or rather, all inclusive in infesting stands of the best trees, poor stands and those between. It appears to be attracted to the true firs, where, during low endemic levels, and after diligent search, it can be found. Douglas-fir, too, is a favored host and exhibits more damaging effects of budworm feeding than any other tree species; spruces and pines are unfavored, although incidental host trees. All these species, of course, suffer severely when fed on excessively.

The Douglas-fir and true fir stands in Colorado, New Mexico, Arizona, and Wyoming have been subject to occasional budworm outbreaks during the past thirty years. None have been as extensive or as destructive as the current one. Each outbreak, even when management carried out direct control, has had a strong undertone of effective natural control. In a Wyoming outbreak during the early thirties, direct control action was barely a contributing factor towards terminating the epidemic. In a

southern Colorado outbreak in 1948, when no direct control was applied, the pest seemed to vanish. A 1955 outbreak in New Mexico subsided even in large blocks where direct control had not been applied. In no instance, however, should it be construed that direct control was a lost cause. Rather, each one emphasized the need for earlier action with the tools available, based on the biological information thus far acquired to forestall damage. There is no doubt that much more investigation of budworm biology is needed, and there should be no question but that earlier application of effective measures should be made.

Spruce budworm is a native pest always to be found in Douglas-fir and true fir stands. Natural factors, some of them unknown, sometimes favor a buildup of the budworm population and subsequent wholesale defoliation of the host trees, in the upperstory by selection, in the understory by consequence.

The virgin and unmanaged stands do not remain static largely because of insects. Most such stands are deteriorating. One of the causal factors is the spruce budworm. Budworm outbreaks will naturally subside, but too often after the stands have suffered tree mortality, growth losses, and malformation of the advanced reproduction.

The current budworm outbreak in Colorado involves over 500,000 acres, an increase in three years from less than 90,000 acres. Tree mortality in 1957, due to budworm feeding, was relatively negligible. Damage to the understory was considerably less then than it is now.

The current outbreak is expected to continue, and, if the trend is followed, it will enlarge. Areas already severely defoliated will lose many mature trees and practically all of the remaining reproduction. The understory of many areas listed as light, and of adjacent unclassified areas, was damaged by budworm in 1960. Those areas, because of defoliation of the understory, inevitably lose status as proposed or potential Christmas tree sale areas.

Control of the budworm is possible by application of DDT in oil solution from aircraft at the rate of one pound of DDT per acre. The feasibility of control must be determined by the forest manager on a basis of economics and aesthetics.

The application of insecticide must be timed to insect development, i.e., stages in the life cycle when the caterpillars are feeding on the foliage. Practical control involves application of the insecticide to large units comprising contiguous infested stands. Application of the insecticide to some portions of a large unit and not to others generally gives short-term results because of the invasion of sprayed areas by egg-laying moths.

Prior to chemical application, it is paramount that the federal and state agencies responsible for game and fish research and management are informed of the program. It would be mutually advantageous for those agencies to partake in the control planning.

TECHNICAL INFORMATION

Causal agent: Spruce budworm, Choristoneura fumiferana (Clem.)

Host trees: White fir, Abies concolor; Subalpine fir, Abies lasiocarpa; Douglas-fir, Pseudotsuga menziesii var. glauca; Engelmann spruce, Picea engelmanni; ponderosa pine, Pinus ponderosa.

Type of damage: The spruce budworm generation that will cause damage next summer had its start when the female moths laid their eggs on the underside of needles of the host trees in late July or early August of this year. The eggs hatch in about ten days, and the larvae overwinter in hibernacula under bark scales on the bole and large branches of the tree. They emerge from their winter hibernacula in late May and begin mining the old needles, and later attack the opening buds, entering them directly through the base or between the opening scales. After entry, they feed upon the developing needles. The new tender needles are fed upon as they emerge from buds not already killed by larval feeding. As development progresses, the larvae bind together with silk the needles at the tips of the outer twigs, forming shelters of dead needles, bud scales and frass. Late in July, after three or four weeks of feeding, the larvae reach maturity and pupate. The moths emerge in 10 to 12 days. There is one generation each year.

When larval populations are large, all new needles and some or all of the older needles are eaten or otherwise destroyed. The trees take on a reddish appearance from the needles that are

killed but not eaten. Successive years of budworm feeding cause a cumulative type of damage. Eventually smaller populations can cause severe defoliation. Trees become weakened from the loss of foliage, and after several years of defoliation no buds will develop.

When the damage reaches the stage where tops and branches are killed, tree mortality is accelerated.

Extent and location of outbreak: Spruce budworm outbreaks were delineated, and the intensities of damage were classified during the 1960 aerial detection survey by Amel E. Landgraf. Survey maps were prepared and submitted to the Regional Forester, Region 2, and to the national forests concerned. The areas of outbreak in Colorado and Wyoming (Table 1) are shown on the accompanying map. The infestations total 516,860 acres in Colorado (349,600 acres in 1959). This includes a new infestation of 60,540 acres on the San Isabel National Forest. All infestations reported in 1959 increased in size except that on the Tierra Amarilla Grant which decreased 350 acres. An outbreak of 300 acres was detected in Wyoming.

Table 1.--Summary of spruce budworm infestations (1960 aerial survey).

Area	Intensity of defoliation 1/				Totals
	Light	Moderate	Heavy	Very Heavy	
	acres				
Colorado					
Pike N. F.	93,900	30,190	3,960	350	128,400
Rio Grande N. F.	17,430	18,920	10,520	1,560	48,430
Routt N. F.	2,300	670	80	0	3,050
San Isabel N. F.	54,320	5,940	280	0	60,540
San Juan N. F.	108,510	139,290	10,730	0	258,590
Tierra Amarilla Grant	310	8,090	2,000	0	10,400
Uncompahgre N. F.	6,500	720	230	0	7,450
Subtotal	283,330	203,820	27,800	1,910	516,860

Table 1 continued

Table 1 continued.

Area	Intensity of defoliation 1/				Totals
	Light	Moderate	Heavy	Very Heavy	
	acres				
Wyoming					
South Bighorn Mountains	0	300	0	0	300
Grand Total	283,330	204,120	27,800	1,910	517,160

1/ Defoliation categories are as follows: Light, defoliation barely visible from the air; Moderate, top one-fourth of tree defoliated; Heavy, one-half of tree defoliated (top-killing in progress); Very Heavy, three-fourths of tree defoliated, tree killing in progress.

No ground sampling?

PROCEDURES

Following the 1960 aerial detection survey, 38 sample plots were selected in outbreak areas on 5 national forests. Collections of branches and examinations for egg mass density were made between August 7 and September 2, 1960.

Two seasonal employees, J. C. Braidwood, and M. J. Zimmer, under the supervision of an entomologist, collected the samples. Egg mass density on each plot was sampled by removing two opposing branches from the mid-crown of each of five dominant or co-dominant host trees, usually Douglas-fir, 50 to 70 feet tall. One side of each branch was measured for determination of foliage area. The twigs from the measured side of each branch were removed and placed in a ten-gallon polyethylene milk can liner for transportation to the examining station.

A garage at the Ranger Station in Del Norte, Colorado, served as the examining room. There four employees, Mrs. D. F. Forister, Mrs. M. Nepp, Mrs. E. Speights, and Mrs. T. G. Hennen, carefully examined all needles, collecting and preserving all that bore foreign objects, and made preliminary classifications of "new", "old", and "parasitized" egg masses. An entomologist made further separations, counted eggs and tallied the accumulated data.

The collected biological data are summarized in tables presented in the body of this report. The term "new" designates 1960 egg masses, both hatched and parasitized. The term "new live" means egg masses in which more than half the eggs had hatched.

The term "dead" refers to the egg masses in which more than half the eggs were parasitized. Foliage area, for measuring new egg mass density, was computed from the base and height measurements obtained when the branches were collected in the field.

From all the "new live" egg masses collected from each sample plot, 25 were picked at random. The hatched and unhatched eggs were counted to estimate the degree of egg mortality.

The 1960 computations differ from those of 1959 in two respects. In the 1959 evaluation all egg masses laid before 1959 were classified as "old"; in 1960 the term "old" refers to egg masses laid in 1959 and tallied in 1960. Also, predictions for 1960 had been based on the ratio of "new live" egg masses to "old" (before 1959). The predictions for 1961 deal with "new" egg masses and "old" (1959) egg masses.

INFESTATIONS ON THE PIKE NATIONAL FOREST

Infestations on the Pike National Forest were more extensive in 1960 than in 1959 (Table 2). New outbreaks developed along the range of mountains from Eleven Mile Canyon Reservoir north to Tarryall Reservoir. Other outbreaks discovered in 1960 are on Thunder Butte and in the Buffalo Creek drainage.

Severe defoliation on the south end of the Tarryall Mountains caused mortality and top-killing of overstory fir and Douglas-fir. Defoliation west of Cheesman Dam was more severe in 1960 than previously; some tree mortality can be expected by 1961 on the east slopes of Sheep Rock. Nearly all the trees on the south slope of Tappan Mountain were completely defoliated; tree mortality will accelerate in this area.

Table 2.--Spruce budworm infestations, Pike National Forest (1958, 1959, and 1960 aerial surveys).

Year	Intensity of defoliation 1/				
	Light	Moderate	Heavy	Very Heavy	Totals
	acres				
1958	11,900	150	0	0	12,050
1959	4,940	35,120	2,250	0	42,310
1960	93,900	30,190	3,960	350	128,400

1/ See Table 1 for definition of categories.

The data from the 1960 evaluation are summarized in Tables 3 and 4. The ratio of new egg masses to old (0.78) is lower than in 1959, as is the density of new egg masses (44.1 new egg masses per 1000 square inches of foliage.) The number of eggs per mass is essentially the same as observed in 1959. Egg mortality has increased from 6.0 percent in 1959 to 30.8 percent this year. The egg parasite responsible for most of this mortality is probably Trichogramma minutum Riley.

Table 3.--Summary of spruce budworm egg mass counts, Pike National Forest, 1960.

Plot no.	Location	Spruce budworm egg masses: Plot totals New 1/ (number)	Old (number)	Ratio New to Old	New per M. sq. in. (number)
1	Lost Creek	186	700	0.27	22.4
2	Wigwam Creek	220	458	0.48	18.5
3	Patterson's Ranch	480	612	0.78	47.5
5	Goose Creek	1197	959	1.25	122.1
6	Springs Creek	317	473	0.67	26.2
7	Twin Creek	239	197	1.21	28.1
	1960 averages	440	567	0.78	44.1
	1959 averages 2/	710	190	3.6	88.9

1/ Includes both hatched and unhatched (parasitized, dead) egg masses.

2/ 1959 data recalculated to compare with 1960 calculations. 1959 data and comparable 1960 data in Tables 19 and 20, Appendix.

Table 4.--Summary of spruce budworm egg counts, Pike National Forest, 1960.

Plot no.	Location	Ave. no. eggs per live mass	Plot totals: Live eggs (number)	Dead eggs (number)	Percent dead
1	Lost Creek	22.6	2215	1988	47.3
2	Wigwam Creek	21.2	2769	1895	40.6
3	Patterson's Ranch	23.4	8270	2962	26.4
5	Goose Creek	24.3	4659	4429	15.2
6	Springs Creek	21.5	4826	1990	6.2
7	Twin Creek	21.7	2582	2504	49.2
	1960 averages	22.5	7554	2628	30.8
	1959 averages	23.7	12749	638	6.0

The most severe defoliation observed during plot sampling was at plot 5, Goose Creek, followed by plots 1 and 3. It will be noted (Table 3) that the number of old (1959) egg masses also follow this order.

Only two plots on the Pike National Forest had a greater number of new egg masses than old (Table 3), these being in the Goose Creek drainage, near Cheesman Reservoir, and in the Twin Creek drainage near the Lake George Ranger Station.

Spruce budworm infestations on the Pike National Forest are expected to continue in 1961. Of the areas sampled in 1960, defoliation will probably be most severe in the Goose Creek drainage and in the vicinity of Patterson's Ranch.. Damage may increase slightly in the Lake George area.

L not sampled?

INFESTATIONS ON THE RIO GRANDE NATIONAL FOREST

Defoliation of true fir, Douglas-fir, and Engelmann spruce on the Forest was more extensive this year than in 1959 (Table 5). Mortality has occurred in much of the understory and many upper crown trees were killed as a result of repeated defoliation. Accelerated tree mortality can be anticipated in all areas of heavy to very heavy defoliation.

The outbreak has spread northeast into the Alder Creek drainage and southeast into the Pinos Creek drainage. Defoliation is heaviest on the west edge of the outbreak.

On the Conejos District, the budworm has caused light defoliation along the south side of the Conejos River, south of the River Springs Ranger Station. Budworm damage was observed in this area in 1958 but not in 1959.

Infestations on the Tierra Amarilla Land Grant have expanded north across the Forest boundary into the drainages of Archuleta Creek and the Rio Chama.

Table 5.--Spruce budworm infestations, Rio Grande National Forest (1956-1960 aerial surveys).

Year	Intensity of defoliation 1/				Totals
	Light	Moderate	Heavy	Very Heavy	
	acres				
1956	16,180	15,160	2,870	0	34,210
1957	23,430	5,610	890	0	29,930
1958	22,270	27,880	1,640	100	51,890
1959	19,550	20,810	3,220	0	43,580
1960	17,430	18,920	10,520	1,560	48,430

1/ See Table 1 for definition of categories.

Compared to the observations of 1959, about half as many new egg masses were laid this year (Table 6). This is reflected in plot totals and egg mass density, or the number of new egg masses per 1,000 square inches of foliage. Egg mortality more than doubled (Table 7) and the number of eggs in each mass was somewhat lower.

Table 6.--Summary of spruce budworm egg mass counts, Rio Grande National Forest, 1960

Plot no.	Location	Spruce budworm egg masses			
		Plot totals (number)		Ratio new to old	New per M. sq. in.
		New 1/	Old		
1	Church Creek	74	161	0.46	7.8
2	Beaver Creek Campground	60	73	0.82	8.3
3	Upper Beaver Creek	117	248	0.47	18.9
5	Trout Creek	120	204	0.59	10.8
6	Park Creek Campground	189	289	0.65	22.8
9	Upper Church Creek	98	199	0.49	16.1
10	Willow Creek	28	116	0.24	3.4
11	Upper Park Creek	91	276	0.33	9.9
12	Grouse Mountain	16	44	0.36	2.4
13	Alder Creek	39	67	0.58	4.7
14	Bighorn Corral	8	46	0.17	1.1
15	Rio Chama	20	31	0.65	3.3
	1960 averages	72	146	0.48	9.1
	1959 averages 2/	165	54	3.2	20.1

1/ See note, Table 3.
2/ See note, Table 3.

Table 7.--Summary of spruce budworm egg counts, Rio Grande National Forest, 1960.

Plot no.	Location	Ave. no. eggs per mass	Plot totals: Live eggs (number)	Plot totals: Dead eggs (number)	Percent dead
1	Church Creek	17.1	552	714	43.6
2	Beaver Creek Campground	14.2	723	129	15.1
3	Upper Beaver Creek	23.6	2663	98	3.5
5	Trout Creek	23.0	2270	490	17.8
6	Park Creek Campground	23.6	3851	609	13.7
9	Upper Church Creek	26.2	1891	676	26.3
10	Willow Creek	14.5	268	139	34.2
11	Upper Park Creek	21.4	1507	440	22.6
12	Grouse Mountain	23.4	292	82	21.9
13	Alder Creek	28.1	835	261	23.8
14	Bighorn Corral	17.5	136	4	2.9
15	Rio Chama	21.4	335	93	21.7
	1960 averages	21.2	1277	311	20.6
	1959 averages	24.2	3874	340	7.9

Defoliation at the sample plots was most severe where the largest numbers of old egg masses were found, plots 3, 5, 6, 9 and 11.. The highest new egg mass densities were also observed in these areas. Similarly, the least severe defoliation was observed on plots 2, 12, 13 and 14 and new egg mass densities were low in these areas, with the exception of plot 2, near Beaver Creek campground.

Budworm defoliation will continue in 1961 in all areas sampled. Damage will be most severe in areas damaged in 1960, and may increase in severity at other locations such as the lower Beaver Creek and Alder Creek drainages.

INFESTATION ON THE ROUTT NATIONAL FOREST

The spruce budworm infestation along the Roaring Fork of the North Platte River west of Delaney Butte was more extensive in 1960 than in 1959. The understory trees have been damaged more severely than the overstory. Some tree mortality was observed in the Red Canyon drainage where defoliation was heavy.

Table 8.--Spruce budworm infestations, Routt National Forest (1959 and 1960 aerial surveys)

Year	Intensity of defoliation 1/				
	Light	Moderate	Heavy	Very Heavy	Totals
	acres				
1959	0	440	0	0	440
1960	2,300	670	80	0	3,050

1/ See Table 1 for definition of categories.

No samples for egg-mass density were collected from the Routt outbreak. Ground observations should be made in 1961 if the infestation persists.

INFESTATIONS ON THE SAN ISABEL NATIONAL FOREST

Infestations were observed and recorded this year on 60,540 acres (Table 1). In general, damage is light. Moderate defoliation with small centers of heavy defpliation were observed in the Muddy Creek area and the Greenhorn Creek drainage west of Rye. Light infestations were scattered along the east side of the Sangre de Cristo Mountains from La Veta Pass north to Hayden Creek.

Spruce budworm defoliation is expected in 1961 at each plot location on the San Isabel National Forest. The number of samples taken in 1960 were not sufficient to give an accurate picture of this large infestation. The number of new egg masses is highest in the Ophir Creek drainage (Table 9).

Egg mortality (Table 10) varied from 1 percent to 8 percent, considerably lower than on the other forests sampled.

Table 9.--Summary of spruce budworm egg mass counts, San Isabel National Forest, 1960.

Plot no.	Location	Spruce budworm egg masses: Plot totals: New 1/	Old	Ratio new to old	New per M. sq. in.
		---number----			(number)
2	Ophir Creek	162	98	1.65	18.2
3	Hardscrabble Creek	60	100	0.60	8.7
4	Oak Creek	62	129	0.48	5.9
	1960 averages	95	109	0.91	10.9

1/ See note, Table 3.

Table 10.--Summary of spruce budworm egg counts, San Isabel National Forest, 1960

Plot no.	Location	Ave. no. eggs per live mass	Plot totals: Live eggs	Dead eggs	Percent dead
			---number---		
2	Ophir Creek	28.4	4416	184	4.2
3	Hardscrabble Creek	26.4	1568	16	1.0
4	Oak Creek	29.2	1664	146	8.0
	1960 averages	28.0	2549	115	4.4

INFESTATIONS ON THE SAN JUAN NATIONAL FOREST

The spruce budworm epidemic continues. Defoliated acreage increased slightly in 1960. (Table 11).

Tree mortality is heavy in the following drainages: Junction Creek; Red Creek (Pine District), West Devil Creek, East Fork of San Juan River (Sand and Quartz Creeks), and the streams east and south of Blanco Basin. Mortality of understory white fir has been heavy; top-killing and tree mortality will increase in areas heavily defoliated.

Several districts on the Forest and owners of private lands in the area lost sizeable Christmas tree sales last year and this year because of damage to white fir.

Table 11.--Spruce budworm infestations, San Juan National Forest and adjacent lands (1957 - 1960 aerial surveys).

Year	Intensity of defoliation 1/				
	Light	Moderate	Heavy	Very Heavy	Totals
	acres				
1957	59,570	0	0	0	59,570
1958	49,770	29,030	790	0	79,590
1959	174,180	75,520	1,790	0	251,490
1960	108,880	147,380	12,730	0	268,990

1/ See Table 1 for definition of categories.

More new egg masses than old were found on 5 of the 16 sample plots (Table 12). High egg mass densities, 23.7 to 32.8 were tallied on three of the plots, only one of which had more new than old. Overall, the number of new egg masses is 69 percent of the old. Egg mass density is about half that of the previous year; egg mortality is four times as great (Table 13).

Table 12.--Summary of spruce budworm egg mass counts, San Juan National Forest, 1960.

Plot no.	Location	Spruce budworm egg masses			
		Plot totals: New 1/	Old	Ratio new to old	New per M.sq.in.
		--(number)---			(number)
1	East Fork San Juan River	107	143	0.75	1.1
2	East Fork Campground	285	357	0.80	32.8
3	Fall Creek	105	92	1.14	13.3
4	West Fork San Juan River	121	108	1.12	14.8
5	Blanco Basin	27	25	1.08	3.6
6	Upper Williams Fork Campground	50	108	0.46	5.7
7	Red Creek (East)	190	175	1.09	32.8
8	Coon Creek	142	285	0.50	18.4
9	Red Creek (West)	40	112	1.36	6.3
10	Vallecito Campground	20	29	0.69	6.1
11	Junction Creek	20	115	0.17	3.0
12	Cade Mountain	54	51	1.06	6.6
13	Little Sand Creek	27	65	0.42	4.6
14	Devil Mountain	56	162	0.35	8.0
15	First Box Canyon	110	254	0.43	10.5
16	North Canyon Creek	161	300	0.54	23.7
	1960 averages	95	149	0.69	12.0
	1959 averages 2/	223	80	2.8	23.5

1/ See note, Table 3.

2/ See note, Table 3.

Table 13.--Summary of spruce budworm egg counts, San Juan National Forest, 1960.

Plot no.	Location	Ave no. eggs per live mass	Plot totals: Live eggs --number--	Dead eggs --number--	Percent dead
1	East Fork San Juan River	22.9	1510	940	38.4
2	East Fork Campground	21.8	3595	2618	42.1
3	Fall Creek	21.8	1235	1054	46.1
4	West Fork San Juan	24.4	2343	610	20.7
5	Blanco Basin	27.2	304	430	58.6
6	Upper Williams Fork Campground	25.4	1151	119	9.4
7	Red Creek (East)	24.8	2399	2313	49.1
8	Coon Creek	32.8	2539	2119	45.5
9	Red Creek	15.2	265	343	56.4
10	Vallecito Campground	29.1	495	87	14.9
11	Junction Creek	17.3	346	0	0.0
12	Cade Mountain	24.0	929	367	28.3
13	Little Sand Creek	15.1	245	163	40.0
14	Devil Mountain	25.3	999	418	29.5
15	First Box Canyon	27.2	2056	936	31.3
16	North Canyon Creek	27.2	2696	1684	38.4
	1960 averages	23.8	1444	888	34.3
	1959 averages	28.0	5975	596	7.7

The most severe budworm defoliation in 1961 will probably be in the areas with plots showing the highest number of new egg masses; namely, plots 1, 2, 3, 4, 7, 8, 15, and 16. Continued damage can be expected at all plot locations.

INFESTATIONS ON THE UNCOMPAHGRE NATIONAL FOREST

The spruce budworm infestation in the vicinity of Ouray was more extensive in 1960 than in 1959 (Table 14). Damage to fir is heaviest in the Cow Creek drainage northeast of Ouray. Some top-killing can be expected in the heavily defoliated areas.

Table 14.--Spruce budworm infestations, Uncompahgre National Forest (1959 and 1960 aerial surveys).

Year	Intensity of defoliation 1/				
	Light	Moderate	Heavy	Very Heavy	Totals
	acres				
1959	0	1,030	0	0	1,030
1960	6,500	720	230	0	7,450

1/ See Table 1 for definition of categories.

Only one plot was sampled on the Uncompahgre, insufficient for making a reliable prediction of infestation trend for the entire infested area. As will be noted in Tables 15 and 16, the number of new egg masses was only one-fifth the old, and there was considerable egg mortality. Spruce budworm damage probably will be light in 1961.

Table 15.--Summary of spruce budworm egg mass counts, Uncompahgre National Forest, 1960.

Plot no.	Location	Spruce budworm egg masses			
		Plot totals		Ratio	New per M. sq. inches
		New	Old	new to old	(number)
1	Dexter Creek	28	135	0:21	3.3

Table 16.--Summary of spruce budworm egg counts, Uncompahgre National Forest, 1960.

Plot no.	Location	Ave. no. eggs per live mass	Plot totals: Live eggs	Plot totals: Dead eggs	Percent dead
			--(number)--		
1	Dexter Creek	24.8	583	111	16.0

SUMMARY AND CONCLUSIONS

Predictions for 1961, based on the 1960 biological evaluation of the spruce budworm in Region 2, U. S. Forest Service: "Spruce budworm infestations persist". As indicated by egg mass density, the feeding will be lighter in some areas and heavier in others than in 1960.

Recurrent budworm outbreaks have been common in the Region. The present outbreak includes relatively large and expanding areas of persistent infestations on the Rio Grande and San Juan National Forests, and more recent and enlarging infestations on the San Isabel, Uncompahgre and Routt National Forests. There is no evidence that any of the separate infestations are terminating.

The observable acreage of spruce budworm defoliation in Region 2 increased 48 percent from 349,600 acres in 1959 to 517,160 acres in 1960.

Biological data were gathered from 38 sample points on five national forests. Analyses of these data suggest that the spruce budworm egg mass density is now somewhat lower than in 1959 (Tables 17 and 18).

It must be recognized that the sampling is extremely limited. The tabulated data display much variation from plot to plot. Predictions based solely on the 1959 and 1960 data, herein summarized, while sound, are necessarily less reliable than had the number of sample plots been greater and had it been possible to analyze data collected for more than two successive years.

The degree of budworm mortality during the coming winter cannot be accurately forecast. Nothing suggests that light to severe defoliation by budworms will not occur in any area sampled during the 1960 egg mass survey. Undoubtedly, the infestations will increase in some areas and decrease in others. Overall, the prediction is continued defoliation, increased rate of tree mortality in mature stands, widespread damage to reproduction, and extension of the outbreak boundaries. Continued defoliation in any degree will probably cause tree mortality in most areas that suffered greatly in recent years.

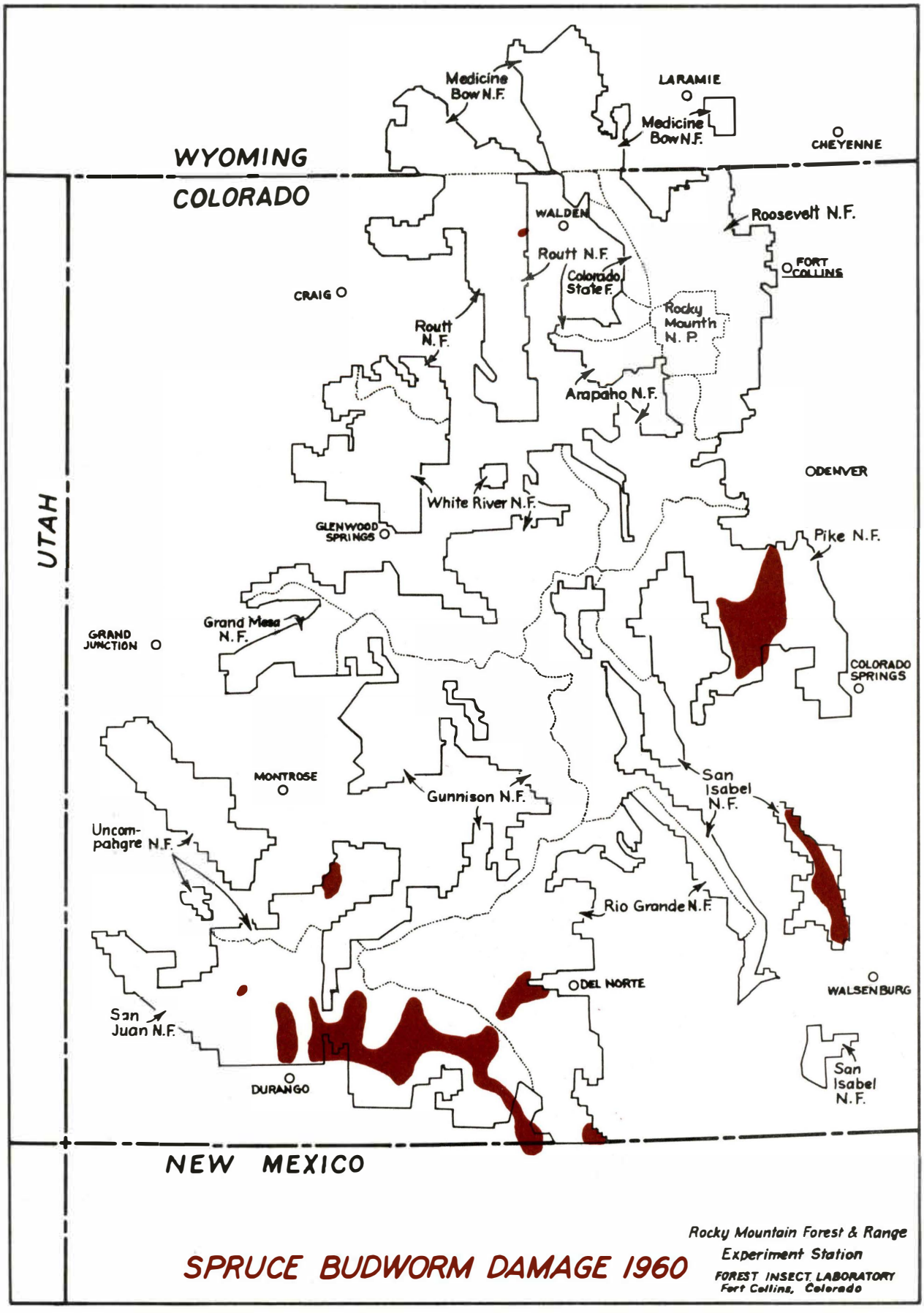
Table 17.--Summary of spruce budworm egg mass counts, Pike, Rio Grande, San Isabel, San Juan and Uncompahgre National Forests, 1959, 1960.

Area	Year	Number of plots	Spruce budworm egg masses			
			Average per plot: New[1]	Old	Ratio: New to old	New per M. sq. in.
			(number)			(number)
Pike N. F.	1959	6	710	190	3.6	88.9
	1960	6	440	567	0.78	44.1
Rio Grande N. F.	1959	11	165	54	3.2	20.1
	1960	12	72	146	0.48	9.1
San Isabel N. F.	1959	0	---	---	----	----
	1960	3	95	109	0.91	10.9
San Juan N. F.	1959	11	223	80	2.8	23.5
	1960	16	95	149	0.69	12.0
Uncompahgre N. F.	1959	0	---	---	----	----
	1960	1	28	135	0.21	3.3
Averages	1959[2]		366	108	3.2	44.2
	1960		146	221	0.61	15.9

1/ See note, Table 3.
2/ See note, Table 3.

Table 18.--Summary of spruce budworm egg counts, Pike, Rio Grande, San Isabel, San Juan and Uncompahgre National Forests, 1959, 1960.

Area	Year	Number of plots	Ave. no. eggs per live mass	Forest totals: Live eggs	Dead eggs	Percent dead
				--(number)--		
Pike N. F.	1959	6	23.7	12749	638	6.0
	1960	6	22.5	7554	2628	30.8
Rio Grande N. F.	1959	11	24.2	3874	340	7.9
	1960	12	21.2	1277	311	20.6
San Isabel N. F.	1959	0	----	----	----	----
	1960	3	28.0	2549	115	4.4
San Juan N. F.	1959	11	28.0	5975	596	7.7
	1960	16	23.8	1444	888	34.3
Uncompahgre	1959	0	----	----	----	----
	1960	1	24.8	583	111	16.0
Averages	1959		25.3	7533	525	7.2
	1960		24.2	2681	811	21.2



Rocky Mountain Forest & Range Experiment Station
FOREST INSECT LABORATORY
Fort Collins, Colorado

SPRUCE BUDWORM DAMAGE 1960

APPENDIX TABLES

Table 19.--Summary of spruce budworm egg mass counts, Pike, Rio Grande, San Isabel, San Juan and Uncompahgre National Forests, 1960.

Area	Number of plots	M. sq.in. foliage	Spruce budworm egg masses: Live new	Old	Dead	Ratio live new to old	Live new per M. sq.in.
			(number)				
Pike N. F.	6	10.1	335	567	105	0.56	33.4
Rio Grande N. F.	12	7.8	60	146	11	0.40	7.7
San Isabel N. F.	3	8.8	93	109	2	0.90	10.8
San Juan N. F.	16	7.5	64	149	31	0.47	8.4
Uncompahgre N. F.	1	8.4	24	135	4	0.18	2.9
Averages		8.5	115	221	31	0.50	12.6

Table 20.--Summary of spruce budworm egg mass counts, Pike, Rio Grande, and San Juan National Forests, 1959, 1960.

Area	Year	Number of plots	M. sq. inch	Spruce budworm egg masses: Live new	Old	Dead	Ratio live new to old	Live new per M. sq.in.
				(number)				(number)
Pike N. F.	1959	6	9.8	674	190	36	3.5	84.5
	1960	6	10.1	335	567	105	0.56	33.4
Rio Grande N. F.	1959	11	8.3	157	54	9	3.0	19.0
	1960	12	7.8	60	146	11	0.40	7.7
San Juan N. F.	1959	11	10.1	210	80	13	2.7	21.9
	1960	16	7.5	64	149	31	0.47	8.4
Averages	1959		9.4	347	108	19	3.1	41.8
	1960		8.5	153	287	49	0.48	16.5